PROJECT 4C

Butte County Groundwater Modeling Program

1. Project Description

Project Type:	**Groundwater/surface water planning**
Location:	**Butte County**
Proponent(s):	**Butte County**
Project Beneficiaries:	**Butte County agricultural and urban water users**
Total Project Components:	**Update existing model to support decision-making about groundwater resources, as well as overall water resource management in the County**
Potential Supply:	**None**
Cost:	**$405,000**
Current Funding:	**Currently none; $140,000 potentially available through the California Department of Water Resources (DWR) Integrated Storage Investigations (ISI) contract**
Short-term Components:	**Model calibration, scenario modeling, annual updates**
Potential Supply (2003):	**None**
Cost:	**$275,000**
Current Funding:	**Currently none; $140,000 potentially available through the California Department of Water Resources (DWR) Integrated Storage Investigations (ISI) contract**
Implementation Challenges:	**Credibility of model and results, local concerns regarding export of groundwater**
Key Agencies:	**DWR, Butte County Department of Water and Resource Conservation, Butte County Water Commission, Butte Basin Water Users Association (BBWUA)**

Summary

BBWUA commissioned Hydrologic Consultants, Inc., (HCI) to develop a groundwater modeling tool for Butte Basin. The study objectives were to assemble data and assess the basin's groundwater resources, develop a quantitative understanding of groundwater system operation, and provide a tool to simulate changes caused by proposed water policy

decisions. Using the computer code FEMFLOW3D (1998), HCI developed the groundwater-flow model with data for (1) groundwater system geometry and hydrology and (2) primary water inflows (recharge) and outflows (pumpage), and (3) measured groundwater levels in wells. The model solves mathematical equations to describe groundwater movement in the basin. In December 2000, the County was granted an exclusive license by BBWUA to manage the model.

As with all models, the Butte Basin groundwater model is a simplified representation of a natural system. Potential computer coding errors, data limitations, conceptual errors, and simplifying assumptions produce analysis errors. Having a credible model will be critical to gaining acceptance for potential groundwater projects or transfers from the Butte County political and public interests, as well as assuring the potential buyers of the water that they are receiving a benefit. An objective peer review of the computer code was conducted by the U.S. Geological Survey. A third-party review of the data considered, the conceptual groundwater system, calibration, and model performance will increase confidence in model results.

This proposed project's objectives are to (1) provide a third-party review of the model, (2) assess the County's long-term operational requirements that the model could meet, (3) determine the County's needs for input and output capabilities, and (4) evaluate how model output could be shared with others. This project would eventually lead to updating the model annually as new data become available and to running groundwater pumping scenarios to analyze the potential impacts on the basin. This information would be used to analyze and decide whether or not the County should approve the proposed transfer.

This project includes both short-term and long-term components. The proposed project would include several tasks important to developing a credible and reliable model. The project would be coordinated with the groundwater monitoring program (Project 4B), which would provide data for the model, and the public outreach component of the Integrated Watershed and Resource Conservation Program (Project 4A), to help the public understand and support the model. In addition to an improved model, the project would result in a list of identified model limitations and uncertainties to help with future model use and modifications. The project tasks are listed below; the first four tasks could be completed concurrently.

Short-term Component

Review Data in Conceptual Model

This task would provide third-party evaluation of the quality and completeness of the data in the model. The conceptual model would be modified according to the data review. Data would be reviewed with consideration of the model objectives and stakeholder needs to ensure that (1) the model produces the necessary output (e.g., groundwater levels) to answer stakeholder questions, (2) the model objectives are reasonable in light of the data available, and (3) temporal and spatial scales are consistent with the data and stakeholder needs for information. The computer model input files and hydrogeologic data would be reviewed to confirm that the conceptual model is adequately represented by the computer model. The data should also be reviewed for methods of interpretation, interpolation, and other processing and analysis. Data to be reviewed include:

- Model area and grid
- Stratigraphy
- Hydrogeologic properties
- Rainfall
- Streamflow
- Stream-aquifer interactions
- Agricultural, urban, and environmental water use
- Land use
- Groundwater pumping
- Initial and boundary conditions
- Modified conceptual model
- Geologic strata

Review Calibration and Provide Re-calibration

Similar to the data review task, this task would provide third-party review and validation of the model calibration. During model calibration, uncertain model parameters are adjusted so that simulated results reasonably match observed conditions. Model performance would be assessed by reviewing calibration statistics and the model's ability to reproduce historical observations, simplifying assumptions and model sensitivity to parameter adjustments, and performing a model post-audit where model predictions (without recalibration) using recently collected data would be compared to observed conditions. The model would be re-calibrated as necessary, depending on the results of the review. In addition, data needed for updating the conceptual model would be identified as part of this task. Model features to be reviewed for calibration include:

- Water balance
- Methodology
- Basinwide groundwater contours
- Local groundwater levels
- Streamflow calibration
- Irrigation practice and operations

Evaluate Input and Output Assumptions

As part of this task, staff or a consultant would evaluate the pre-processors to suggest modifications to make data input more efficient and the post-processors to suggest modifications that would create more graphical and visually comprehensible output that is linked to Geographic Information System (GIS) data. The recommended modifications would be made to allow the model to be used by a range of staff and to allow the output to be easily understood by the public and be useful to a non-technical audience.

Develop Scenarios

The base case scenario would be identified and developed. A proposed project scenario would also be developed.

Create Summary Report

A report summarizing the data and calibration modifications, the input and output modifications, the base case scenario, and the project scenario would be written to create a record of the model changes and to help with future scenarios and model updates.

Long-term Component

The primary purpose of this evaluation is to evaluate the potential for this project to provide water supply benefits in the short-term (by end of 2003). As part of this initial evaluation, potential long-term components of the proposed project (defined as any part of the project proceeding past or initiated after December 2003) have been considered on a conceptual level. Further consideration and technical evaluation of long-term component feasibility and cost will occur as the next level of review under the Sacramento Valley Water Management Agreement. Long-term-component project descriptions are included in these short-term project evaluations only as a guide to the reader to convey overall project intent.

The ultimate goal of the groundwater modeling program is to support decision-making about groundwater resources, as well as overall water resource management in the County, and to facilitate the proper planning and management of these projects. With annual reviews and updates, the model could be used for an extended period of time. Butte County assumes that its program would be funded from water sales from there on.

Update Model

Using the data derived annually from the groundwater monitoring program and other sources, the model would be updated annually to ensure that it improves its performance and to help maintain public information on and support of the model.

Several tasks related to the modeling project would begin immediately after funding. The start of the project would only be delayed by the time required to arrange for staff or a consultant to support the proposed activities. The proposed project schedule is detailed in Table 4C-1, assuming that the project would be underway in January 2002.

TABLE 4C-1
Estimated Project Schedule
Butte County Groundwater Modeling Project

Task	Duration	Completion Estimate
Review Data in Conceptual Model	6 months	June 2002
Review Calibration and Provide Re-calibration	6 months	June 2002
Evaluate Input and Output Assumptions	1 year	December 2002
Develop Scenarios	1 year	December 2002
Create Summary Report	3 months	March 2003
Update Model (Annual)	4 years	December 2007

2. Potential Project Benefits/Beneficiaries

The groundwater modeling project would be a key part of groundwater management in the County and is necessary to evaluate the acceptability of any potential conjunctive use or water transfer projects. Improved management of the local groundwater resources could in

turn provide numerous benefits to Butte County water users, downstream water users, and Delta water needs. This effort could quantify sustainable pumping quantities and the required recharge to maintain acceptable groundwater-level seasonal fluctuations and avoid long-term drawdown of the groundwater table.

Water Supply Benefits

This project would not produce any direct benefits to existing water supply. However, this effort could quantify sustainable pumping quantities and the required recharge to maintain acceptable seasonal groundwater-level fluctuations and avoid long-term drawdown of the groundwater table. Review and validation of the model would help to generate public support for the existing model. An accepted groundwater model would assist with planning any proposed conjunctive use projects in the County. Ultimately, information gathered from the model would lead to managed conjunctive use projects with real water supply benefits.

Primary beneficiaries of improved groundwater resource management would be agricultural and urban water users in Butte County. Any new supply created would supplement surface water supplies and firm up water needs in dry years for users. Surface water normally diverted could be made available to downstream users.

Water made available through a developed conjunctive use project could be used to meet environmental demands in the Delta or other water bodies. Increased groundwater pumping could result in reduced surface water diversions, which would increase in-stream flows or help meet water quality standards in the Delta.

Water Management Benefits

Developing the tools for proper groundwater and surface water management within Butte County is the focus of this project. Proper management and an understanding of the impacts of increased groundwater development will be critical if any proposed conjunctive use projects or other groundwater resource projects are to be implemented. Specific benefits resulting from such projects could include firming dry-year supplies for local water-short areas.

Environmental Benefits

The proposed project would provide valuable information that could be used to evaluate future conjunctive use projects. Future conjunctive use projects would use the data and related model to determine environmental benefits in terms of water quantity. Reduced surface water diversions could result in more water for in-basin and out-of-basin users, including environmental designees.

Water Quality Benefits

The model would use data from the groundwater monitoring program to help evaluate impacts on groundwater quality. The base case scenario would help to establish a baseline for groundwater quality, and future model scenarios may help to identify possible sources of contamination.

3. Project Costs

The cost opinions shown, and any resulting conclusions on project financial or economic feasibility or funding requirements, have been prepared for guidance in project evaluation from the information available at the time of the estimate. It is normally expected that cost opinions of this type, an order-of-magnitude cost opinion, would be accurate within +50 to -30 percent. Project costs were developed at a conceptual level only, using data such as cost curves and comparisons with bid tabs and vendor quotes for similar projects. The costs were not based on detailed engineering design, site investigations, and other supporting information that would be required during subsequent evaluation efforts.

The final costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. As a result, the final project costs will vary from the opinions presented here. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help ensure proper project evaluation and adequate funding.

Table 4C-2 lists the cost breakdown for the modeling tasks described above.

TABLE 4C-2
Implementation Costs
Butte County Groundwater Modeling Project

Task	Cost ($)
Review Data in Conceptual Model	60,000
Review Calibration and Provide Re-calibration	70,000
Evaluate Input and Output Assumptions	50,000
Develop Scenarios	95,000
Create Summary Report	10,000
Update Model ($30,000/year for 4 years)	120,000
Total:	**405,000**

Other Sources of Funding

Funding has not been secured for this project. Funding for the first four tasks (a total of $275,000) is most urgent so that review and modification of the model may begin right away to support other Butte County projects and planning. Funding requested for the entire project totals $405,000.

4. Environmental Issues

This project is primarily an exercise in data collection and analysis. No physical impacts are anticipated to occur as a result of the project, although the results of the project may lead to the development of future projects.

A draft California Environmental Quality Act (CEQA) checklist was not prepared for this proposed project because no physical alterations to the environment would occur as a result of this proposed action.

5. Implementation Challenges

There are serious concerns about the long-term drawdown of groundwater tables and land subsidence as a result of any conjunctive use program. Although completion of the groundwater model would help improve decision making regarding groundwater use, public perception of conjunctive use projects may make acceptance of the model and its results difficult. Local involvement would be required to gain acceptance of the model and its validity. Having the model grounded in current, publicly-accepted data would help create public confidence in the model, and the model results may be more believable when groundwater resource projects are evaluated.

Long-term exporting of in-basin water supplies is a very sensitive political issue. Estimates of local benefits and exported water would have to be a part of any future conjunctive use program. The local opposition would likely increase as the water produced is mostly for export. A public outreach program incorporated with the modeling program may be required to address public perception.

Key Stakeholders

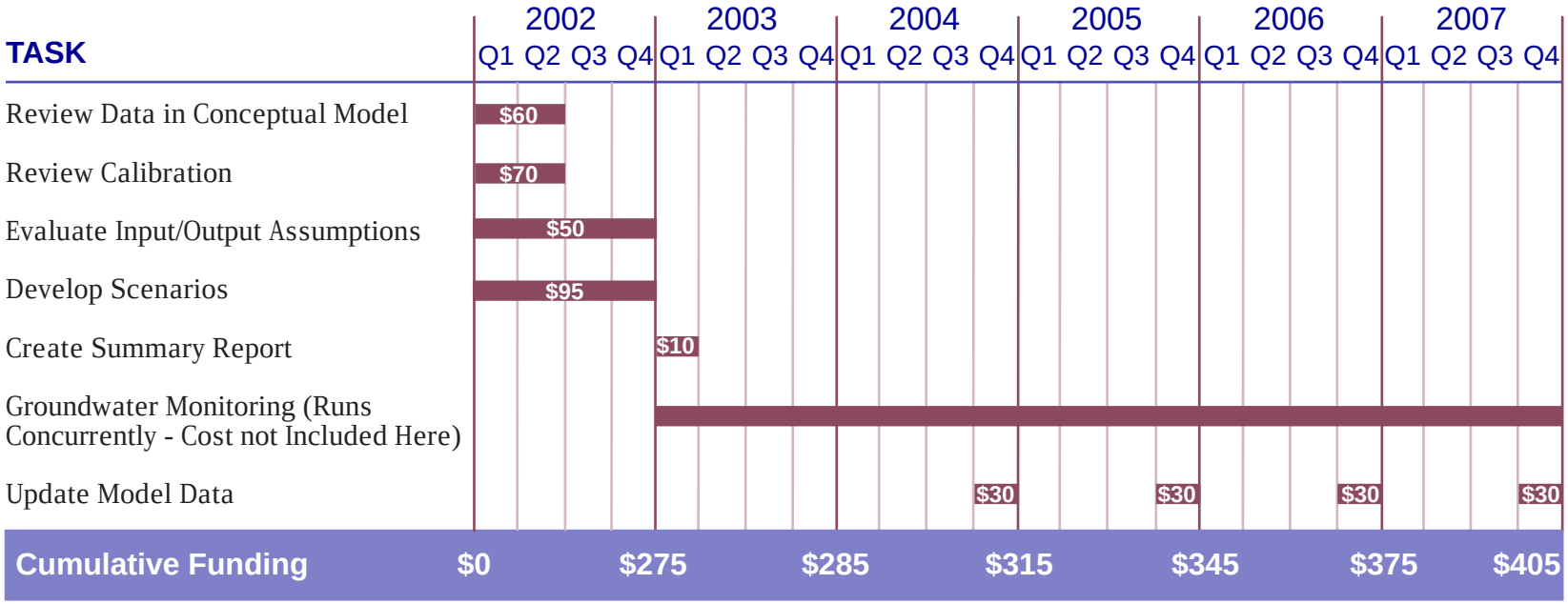
Table 4C-3 describes some of the key stakeholders that would be involved with the implementation process. These stakeholders would likely be involved regarding the impacts and benefits of future groundwater resource projects.

TABLE 4C-3
Stakeholder Roles and Issues
Butte County Groundwater Modeling Project

Stakeholder	Role	Issues
Butte County Department of Water and Resource Conservation	Model exclusive licensee and model project lead	Quantify potential for development, safe yield, protect existing surface water rights, overdraft, land subsidence
Butte County Water Commission	Groundwater developers	Make sound decisions associated with potential conjunctive management projects
Irrigation districts, cities, landowners	Groundwater users	Groundwater levels, export of groundwater out of basin
South-of-Delta exporters	Potential beneficiary of new supply	Availability of new water for export
Various locals interest groups	Protect local economy	Export of new water
Environmental interests	Habitat protection for Sacramento River and Delta	Effect on Sacramento River and Delta inflow: timing, temperature, quantity
DWR	Support groundwater monitoring and model projects; provide data	Coordination with related projects/efforts
BBWUA	Surface water suppliers	Model ownership

6. Implementation Plan

This project is ready to proceed upon complete funding. Assuming that the project would begin in January 2002, most tasks would be completed by early 2003. The estimated completion date for ongoing model updates is December 2007; however, with continued updates, the model would be useful beyond 2007. The time schedule includes 1 year to complete the first four tasks (review data, review calibration, evaluate input and output, develop scenarios) concurrently, 3 months to write the summary report, and annual updates of the model. Figure 4C-1 shows the general schedule for the modeling project, which is assumed to be complete in December 2007. This project would be coordinated with the Butte County Groundwater Monitoring Program and the Butte County Integrated Watershed and Resource Conservation Program.



NOTE: ALL DOLLAR AMOUNTS X 1,000

FIGURE 4C-1
PRELIMINARY IMPLEMENTATION SCHEDULE
BUTTE CO. GROUNDWATER MODELING PROGRAM
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK
SWRI